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ABSTRACT

The effectiveness of environmental simulations in developing students' awareness of environmental issues, whether perception of environmental relationships was affected by the simulations, and whether the use of microcomputers as the medium of instruction affected student attitudes towards computers were investigated in this study. Undergraduates (N=110) enrolled in an introductory natural resources course at the Ohio State University participated in the study. The treatment group used three microcomputer simulations that were incorporated into the course as individual learning modules while the control group worked with comparable workbook modules. Content presentation techniques were assessed through a knowledge subtest instrument and an Environmental Relationship Perception Survey. A Computer Awareness Survey measured attitudes toward computer enjoyment, anxiety, and user efficiency. The knowledge subtest results were significantly higher for the treatment groups suggesting that computer simulations are more effective for factual recall. However, the lack of significant changes in responses to the Environmental Perception Survey indicated that use of microcomputer simulations may not produce marked results in terms of higher cognitive processes. There was little in the data from the Computer Awareness Survey which would support the idea that increased exposure to computers results in more favorable attitudes toward them. References, tables and figures are appended. (ML)

EFFECT OF MICROCOMPUTER SIMULATIONS ON COMPUTER AWARENESS AND PERCEPTION OF ENVIRONMENTAL RELATIONSHIPS AMONG COLLEGE STUDENTS

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EFFECT OF MICROCOMPUTER SIMULATIONS ON COMPUTER AWARENESS AND PERCEPTION OF ENVIRONMENTAL RELATIONSHIPS AMONG COLLEGE STUDENTS

Environmental management education emphasizes the interrelatedness of many disciplines in the process of understanding and solving environmental problems. Successful learners in an environmental management curriculum should be able to develop their own methodology for solving complex problems. Fundamental to the development of such problem solving behavior is experience with the complexity of real world problems. Such direct experience is impossible in the typical classroom setting, and unfortunately few educational techniques are available to demonstrate the complex relationships that must be handled.

Environmental simulation programs utilizing microcomputer technology offer a method of demonstrating in a simplified version real world conditions, providing learning experiences that illustrate many sides of an issue, allowing manipulation of a number of variables and offering immediate feedback (Damarin, 1982). Compared with direct experiences computer simulations offer decreased operating costs, increased safety, increased availability of experiences and reduction of space requirements (Cohen, 1980). Properly constructed simulations reportedly can provide students with experiences that can motivate them to seek or develop alternatives to existing real world conditions (Pager, 1982).

Microcomputer-based instructional programs may have advantages in

producing cognitive gains. A reanalysis of 51 studies of computer use in secondary education programs (Kulik, Bangert and Williams, 1982) found that computer-based instruction raised students' final examination scores an average of 13 percentile points. Few of the studies dealt specifically with simulations, and none were environmental in their subject matter. Ellinger and Brown (1979), however, used a computer simulation to teach spatial location theory. They found that students developed increased abilities in problem solving and in relating concepts that dealt with multiple processes. One of the concerns in the present study is whether the environmental simulations can be effective in developing awareness of environmental issues and perception of the relationships involved.

There is also concern regarding the effect of the use of new instructional technology on user attitudes. Mixed results are reported in the literature for affective changes resulting from such experiences. Saracho (1982) found that students assigned to computer treatments liked the computer less but learned more than those using other media. Rubin and Geller (1979) determined that students using the Biological Systems Analysis and Simulation Laboratory showed positive attitudes toward computer simulations. Eighty percent of the students reported that they enjoyed the simulations and also increased their computer awareness. The Minnesota Educational Computing Consortium (MECC) developed an instrument that measured among other attributes a student's enjoyment, anxiety and perception of ability to use the computer (Anderson, Klassen, Krohn and Smith-Cunnien, 1982).

Applied to students before and after use of APOLUT, a water pollution simulation, no immediate changes in affect were measured. Six months later, however, the group that used the simulation had a significantly higher computer awareness, including a reduction in computer anxiety and more positive attitudes toward computers (Anderson, Klassen, Hansen and Johnson, 1980-81). The second concern addressed in this study, then, is the effect that use of microcomputer technology may have on students' attitudes toward the technology.

OBJECTIVES

The following questions were the focus of this study:

1. What effect does use of environmental simulations have upon student knowledge of certain environmental issues?
2. What effect do the simulations have upon students' perception of environmental relationships?
3. Does the use of microcomputers as the instructional medium affect students' enjoyment of computer use, anxiety concerning computers and perception of their ability to use the computer?

METHODS AND DATA SOURCES

The 110 students enrolled in the Ohio State University undergraduate course entitled "Introduction to Conservation of Natural Resources" were divided into two groups based on a computer-generated list of random numbers. The treatment group used three microcomputer simulations that were selected to support course

goals. These simulations were identified through software directories, educational computing magazines and vendor catalogs, and were evaluated for their relationship to course objectives, ease of use by novices, quality of documentation, and availability of hardware. Those chosen were

1. Ecological Modeling, from CONDUIT, stressing factors affecting population growth in any ecosystem.

2. Demographics, from CONDUIT, which uses age pyramids and population/time graphs to facilitate understanding of demographic dynamics and the impact of factors that affect the size of the human population.

3. Limits, from the Minnesota Educational Computing Consortium (MECC), which shows how complex the relationships are between industrial output, pollution, population, food supply and natural resources.

The three simulations were incorporated into the course in the form of individual learning modules. Each simulation's module consisted of written background information on the topic, instructions for operating the computer and the program, and a summary worksheet. The format and utility of one module was pilot tested with another undergraduate natural resources course, and feedback from students was used to modify all modules. Selected students then tested all the revised materials before they were used in this project.

Comparable instructional modules were developed that did not use the computer simulations. These modules, administered with the

control group, consisted of textbook and other reference material assembled so as to cover the same concepts as the computer-based modules. These "workbooks" included a worksheet identical to the one used by the treatment group.

The three modules were offered sequentially during the Spring quarter of 1983. Students were required to arrange one hour per module outside of class for completion of the assignments. During those periods, technical assistance with the computer hardware was provided, but no discussions of the content of modular materials were offered.

In order to evaluate the relative effectiveness of the content presentation techniques (research questions 1 and 2), two types of instruments were designed by the researchers:

1) Knowledge Subtest of the factual content of the modules. Nine multiple choice items on the final course examination comprised this evaluation component. Reliability of this subtest was not measured because of the small number of items, but the KR-20 for the entire 100-item test was 0.845. Individual item difficulty for these 9 items ranged from .04 to .61.

2) Environmental Relationship Perception Survey: thirty statements were developed in which students were asked to rate the strength of the effect that some action would have on various factors in the environment. Biological, sociological, political and economic factors were included

in the questions. A five-point Likert scale response range from "No effect" to "Strong effect" was used. This instrument was validated by a jury of faculty and graduate students in OSU's Division of Environmental Education.

No references to a testing format such as that in the Relationship Perception Survey were found in the literature, so this study served as a pilot test for the technique. Question format is illustrated in Figure 1. "Correct" answers were not sought by the instrument, but instead it was designed to measure shifts in perception of environmental relationships following the treatment. It was expected that module completion would result in indications that all parts of the environment are related to all other parts, thus posttesting should reveal shifts toward the "strong effect" end of the scale.

FIGURE 1 HERE

An answer to the third research question was sought through pre- and posttests accompanied by intensive time-series measurements using a third instrument:

3) Computer Awareness Survey: twenty statements with Likert scale responses regarding computer enjoyment, anxiety, user efficacy, educational computer support, and policy concern. These were derived from a thirty-item test

developed by the Minnesota Educational Computer Consortium (MECC) and tested extensively with seventh and eighth graders in Minnesota (Anderson, et al., 1982). Dimensions of the survey were determined by MECC by factor analysis, and reliabilities of the dimensions ranged from 0.64 to 0.83 (Anderson, et al., 1982).

The MECC and Relationship surveys were administered in the following way. Random sortment of the test forms resulted in one-half the class taking each survey on the first class day, and the randomization process was repeated for a similar testing procedure on the last class day. Neither randomization coincided with that under which students were chosen for treatment or control groups.

Microcomputer modules were assigned beginning in the third week of a ten week quarter. At the same time, attitude observations were begun and repeated in each lecture period. This constituted an intensive time-series testing schedule designed to indicate changes in attitudes with increasing levels of exposure to computer use. Each day as they entered the classroom students received a single item from the MECC instrument. Items were stacked at the entryway ccording to a daily random order of item numbers. Responses were coded on the forms, which were then signed and deposited in boxes labelled for Groups A and B (treatment and control).

Participation in the daily attitude data collection was voluntary, with daily response rates varying from 51 to 91% of the class. Module completion was required for all students by designated

dates within the quarter. In addition to pre- and posttest scores, research data for each student included three dates of module work, the dates on which attitude responses were received, the daily attitude item numbers and the responses to them.

The Knowledge Subtest was administered to all students as a posttest only to assess specific content acquisition in relation to the two information sources. As a form of qualitative evaluation, an anecdotal record was made of such things as verbal evaluations of the experience, amounts of time spent on each module, and reactions to the subject matter. Each student in the treatment group completed a written evaluation after use of each microcomputer simulation. This gave the students an opportunity to rate each module on the clarity of its instructions, applicability to course content, ease of use and amount of time required.

RESULTS

Seventy-nine students (71.8% of the class) completed all three modules and the posttest. Of this group 40 were in the treatment (computer) group and 39 were in the control (workbook) group. Seventy-two percent of the treatment group and 84.6% of the control group were freshmen or sophomores. The treatment group consisted of 57.5% males and 42.5% females; the control group had 61.5% males and 38.5% females. A comparison of the demographic structure of the class from which the sample was drawn with groups enrolled in the same course in 1982 indicated that the study sample was comparable in class rank, sex, and means on the final exam.

Knowledge. On the Knowledge Subtest (Table 1) a t-test indicated that the treatment group outscored the control group at a significant level ($p=0.02$). Total scores on the complete final exam and grades for the course were not significantly different between the two groups.

TABLE 1 HERE

Relationships. On the Environmental Relationship Perception survey, pretest responses for the two groups differed on ten of the original 30 items. These ten items were eliminated from analyses, leaving pretest mean responses that did not differ significantly between groups at the .05 level (Table 2).

A factor analysis of responses following treatment did not produce interpretable groupings of items. However, comparisons between groups on the two item sets most closely related to the content of the modules indicated a possible pattern of response shifts. The computer modules were expected to reveal clearly that all the environmental variables included (e.g. population, food supply, industrial output, pollution, natural resource use and others) were in some way related to each other. Responses to item sets C, D and E (Table 2) indicated clear differences between treatment and control groups. The treatment group shifted positively on nine of twelve relationships, indicating that a stronger relationship was perceived following treatment. The control group shifted positively on only two of the same items.

TABLE 2 HERE

It may therefore be that such an instrument is a useful method of detecting perception of relationships, but only if the

relationships have been specifically identified through a treatment. The ability to generalize from one set of relationships to another was apparently not acquired through the computer treatment, or else the three-hour exposure was not sufficient to effect the desired transfer of learning. What may be of greater concern is that the standard method of presenting such information, e.g. workbook with readings, actually resulted in a lowered perception of relationship strength. While neither the gains by the computer group nor the losses by the workbook group were significant at the .05 level, educators seeking effective methods of communicating interrelationships will note the differences resulting from these two media.

Attitudes. Of the attitude items chosen from the MECC instrument only those related to enjoyment (5 items), anxiety (5) and efficacy (4) were strong enough in a factor analysis of the pretest to be considered in the results. In the time-series component, means of the items taken on a given day within each of the three factors were summed to produce three factor scores for that day. Also tabulated was the number of modules completed by a student by the time he or she responded to a given attitude item. Therefore there was a time dependent sequence of number of modules completed and attitude scores for the group on each of the three factors.

Two analyses were done on these data. The first was a

series of corrrelations between modules completed and each of the factor scores. Of the six correlations (three for each of the two groups) none were significant ($p<.05$).

The second analysis was a 2 by 3 by 4 analysis of variance which included the two groups, three attitude factors and four possible numbers of experiences with modules, 0, 1, 2, or 3. No significant main effects were observed, but an F value of 2.1 significant at the .05 level was observed among the three-way interactions (Table 3). These data are plotted in Figures 1, 2 and 3. Figure 1, a plot of the enjoyment factor, indicates that the two groups were quite different prior to experience with the modules, with the control group expressing greater enjoyment regarding computer use. The two groups converged as the experimental group gained experience with microcomputers with the net effect that both groups ended up enjoying computers less.

TABLE 3 HERE

On the anxiety subscale the control group fluctuated widely, starting out more anxious than the experimental group, becoming less anxious with the first module then more anxious and then less again. On the third subscale, which reflects perception of ability to use computers, the control group became very confident in comparison to the experimental group following their completion of the second module.

FIGURES 2, 3 AND 4 HERE

DISCUSSION

This study has indicated that the short term use of microcomputer simulations may not produce marked results in terms of stimulating the higher cognitive processes as postulated by Kidder, Horowicz and Kiselwich (1973) for simulations in general. This is indicated by the lack of significant changes in response to the Environmental Relationship Perception Survey following treatment. Such results may be related to some qualitative observations made during the treatments. For example, even though instructions were complete and requirements pretested for clarity, students expressed frustration because they did not understand how the information in some modules could be applied or what the implications of the simulations might be. The students were also concerned because "correct" answers were not apparent in the exercises. In a course with evaluations based largely on objective measures, the open ended nature of simulations was something of a threat to grade security.

Such responses may indicate a need for more student/computer interaction, or for extensive briefing and debriefing related to computer simulations. Rather than leaving students to their own devices for interpreting and applying their simulation results,

intervention of an instructor may be necessary. A major value of simulations is derived from the discussion and the applications they generate, but a student working alone with a machine does not benefit from such interactions. It may also facilitate achievement of the objectives of a microcomputer simulation if the response collecting device does not have the appearance of a worksheet, which implies an objective gradeable outcome for the experience.

As a teaching method for factual recall, however, the computer simulations appeared to be more effective than workbook modules, since the Knowledge Subtest results were significantly higher for the treatment group. Interestingly, some computer users had indicated feelings that the material from the simulations could have been taught as effectively using standard textbook methods. They did not see the computer as enhancing their learning. Apparently this was not the case for most students. Students' perceptions of effectiveness were possibly related to their perception of course goals and to the relative degree of comfort they would have felt in having customary materials from which to study.

As for the attitudes toward computers, the patterns in the time series study are not easily interpretable. It does appear that those students not using the computers exhibited a much less stable pattern of attitudes than did those that were using the computer. It would seem that first hand knowledge of something,

such as computers, provides a reality base for individuals to be able to form informed opinions. Such opinions then become quite stable, whereas lack of such a reality base allows opinions to vary greatly from time to time.

It is apparent that increasing use of computers had little effect on attitudes toward the technology. Only on factor 3, perception of ability to use computers, is there a noticeable departure from the general pattern. The dip in that curve may be explained by the fact that the second module was apparently much more difficult than the others and took almost thirty minutes longer to complete. This may have lowered students' confidence in their ability to use computers.

In interpreting the data it must be kept in mind that even beginning attitude scores were relatively high, ranging from a low of 3.42 to a high of 4.19 on a five point scale. The use of the computer generally seemed to solidify these initially positive attitudes.

There is little in the data from this study, then, which would support the idea that increased exposure to computers results in more favorable attitudes toward them. What is encouraging, however, is that increased exposure seems to provide stable, realistic attitudes. Perhaps this is the important element in computer awareness programs underscoring the value of providing frequent and sustained opportunities for computer use.

Experience with this study has suggested several ways in

which the design of a future study could be improved. The modified intensive time-series design (Mayer and Monk, 1983) used in this study for attitude assessment was able to reveal a different pattern of attitudes between the computer users and the non-users. This type of design should be used more frequently when looking at attitudes. It has the potential of revealing patterns which may be far more meaningful than simple before and after differences revealed by the most frequently used designs.

More sophisticated methods of data collection and even exposure to microcomputer simulations are becoming available through the use of master/slave computer setups, in which a central processor feeds information sequentially to a number of satellite computers. Student responses can also be received from each slave computer and recorded by the master, which then presents the next sequence of information. Daily attitude response rate could be improved with such a system, and a larger number of students could use a simulation at one time than has been possible previously.

With limited amounts of hardware available, the methodology for implementing microcomputer usage into a large lecture course includes the scheduling of small groups or individuals for computer sessions. While achieving this with some success in this project, the necessity for small groups leads the authors to believe that such applications of microcomputer technology may be best utilized in smaller classes. This would facilitate

discussion and interaction that could maximize the educational potential of existing computerized environmental simulations.

REFERENCES

Anderson, Ronald E., Daniel L. Klassen, Thomas Hansen and David C. Johnson. 1980-81. The affective and cognitive effects of microcomputer-based science instruction. Journal of Educational Technology Systems 9(4): 329-355.

Anderson, Ronald E., Daniel L. Klassen, Karl R. Krohn and Phil Smith-Cunnien. 1982. Assessing Computer Literacy. Final Report. St. Paul: Minnesota Educational Computing Consortium.

Bazan, Eugene J. 1976. Environmental simulation games. Journal of Environmental Education 8(2): 41-51.

Cohen, Eli. 1980. The future of educational computer simulation. University of California-Davis. (ERIC Document Reproduction Service No. ED 190 118).

Damarin, Suzanne K. 1982. Computers and education: Some observations. Keynote Address, Second Annual Microcomputer Conference. Oklahoma State University.

Ellinger, Robert S. and Bobby R. Brown. 1979. The whens and hows of computer-based instructional simulation. Association for Educational Data Systems Journal 12(2): 51-62.

Goodman, Frederick. 1981. Computers and the future of literacy. Proceedings, National Computer Conference.

Kidder, Steven J., Richard E. Horowicz and Gary M. Kiselwich. 1973. An instructional model for the use of simulation games in the classroom. Baltimore: Johns Hopkins University.

Kulik, James H., Bangert and Williams. 1983. Effects of computer -based teaching on secondary school students. Journal of Educational Psychology 75(1): 19-26.

Mayer, Victor J. and John Monk. 1983. Handbook for Use of the Intensive Time-Series Design. Columbus, OH: The Ohio State University.

Pager, John M. 1982. Simulations - a valuable learning technique. Environmental Education Report 10(5): 1-2.

Rubin, Howard and Jacob Geller. 1977. Computer simulation as a teaching tool in biology - a case study: The Biological Systems Analysis and Simulation Laboratory of the City University of New York. Journal of Computer Based Instruction 3(3): 91-96.

Saracho, O. N. 1982. The effect of a computer assisted instruction program on basic skills achievement and attitude toward instruction of Spanish speaking migrant children. American Educational Research Journal 19(2): 201-219.

TABLE 1

Scores on subtest of final exam for students completing computer modules (Treatment) and those completing workbook modules (Control)

Group	N of Cases	Mean	Standard Deviation	t	Prob.
Computer	40	7.10	1.236	4.38	0.039
Control	39	6.44	1.569		

TABLE 2

Comparison of responses of treatment and control groups on the Environmental Relationship Perception Survey.

Effect of	N of Items	Relationship Perceived * Pretest Treatment	Pretest control	Posttest Treatment	Posttest Control
Overhunting a predator species	2	3.35	3.50	3.54	3.42
Tellico Dam construction	5	3.16	3.13	3.06	3.12
World population increase	3	4.20	4.30	4.31	4.06
Indiscriminate use of resources	5	3.82	4.14	4.02	3.88
Decreasing energy consumption	5	3.54	3.63	3.64	3.22
Weighted Mean		3.60	3.72	3.68	3.51

* 1 = no effect; 5 = strong effect

TABLE 3

Summary of ANOVA comparing groups, number of modules and attitude factors

Source of Variation	df	MS	F	p
Main effects				
Group	1	2.4	2.1	0.15
Modules	3	0.79	0.72	0.54
Factor	2	13.3	12.0	0.00
2-way interactions				
Group - modules	3	0.23	0.21	0.89
Group - factor	2	0.53	0.48	0.62
Modules - factor	6	1.[illegible]	1.5	0.19
3-way interactions	6	2.3	2.1	0.05

FIGURE 1

Sample items from the Environmental Relationship Perception Survey

In the following questions you are to rate the strength of the effect or interaction of the factors indicated on a scale of 1-5, where 1 indicates no effect and 5 is a very strong effect.

1	2	3	4	5
No effect				Strong effect

D. What effect will the indiscriminate use of the world's natural resources have on the following factors?

1. world population growth
2. present generation's income
3. individual energy costs
4. food availability
5. industrial production

E. In the past several years the American public has been decreasing its energy consumption. How does this trend affect the following factors?

1. research into energy alternatives
2. air pollution levels
3. U.S. employment rate
4. steel production
5. food prices

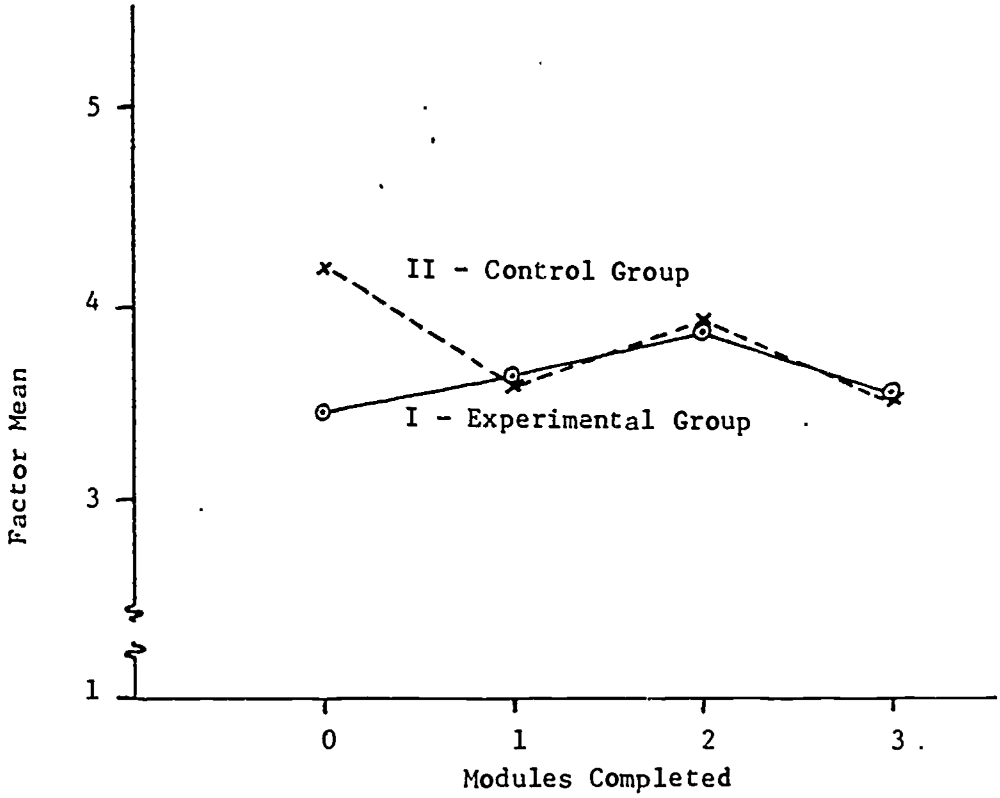

Figure 2. Factor I, enjoyment in using computers.

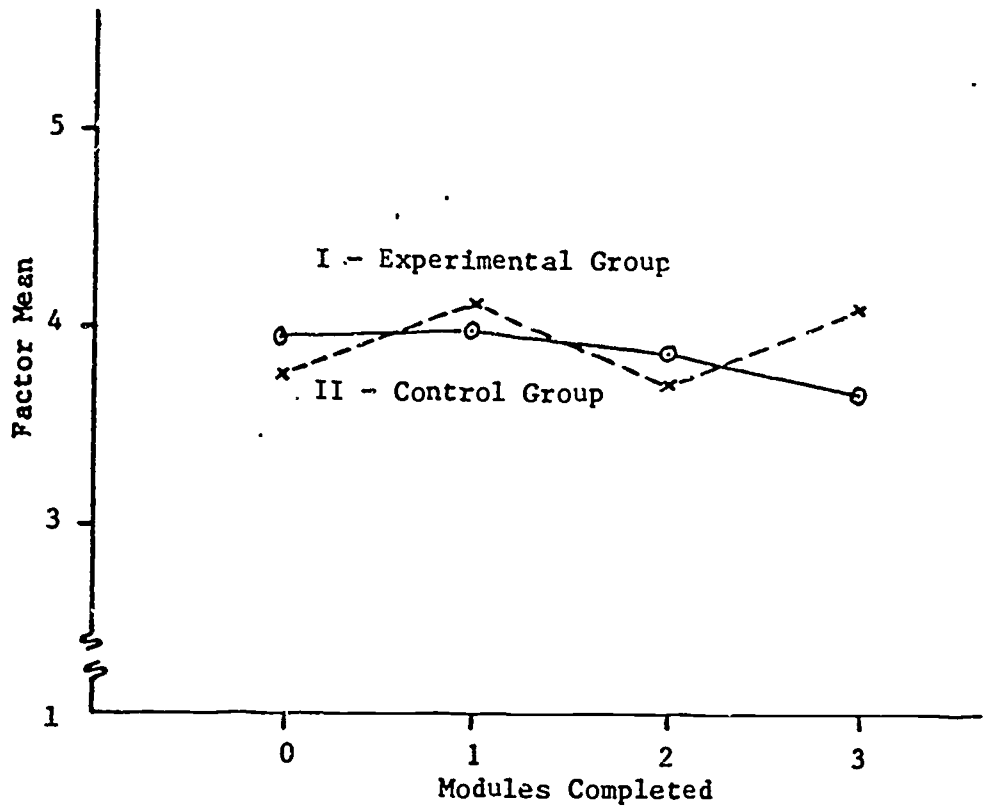

Figure 3. Factor II, anxiety toward computer use.

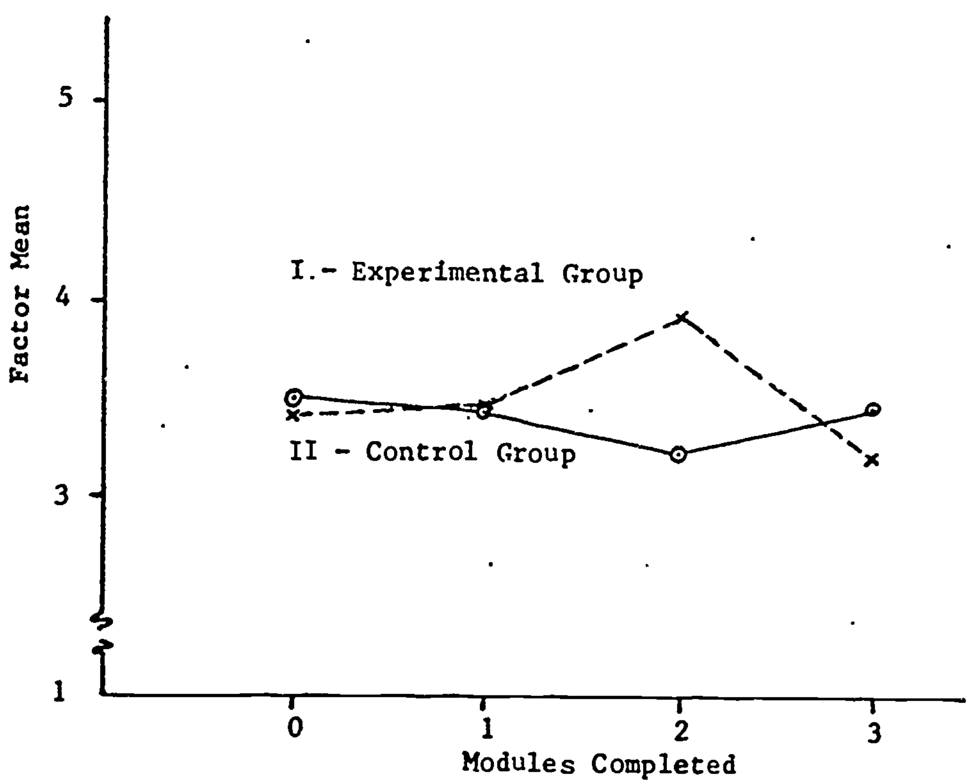

Figure 4. Factor III, perception of ability to use computers.